PUBLIC HEALTH ASSESSMENT
Evaluation of Potential Exposures to Contaminated Off-Site Groundwater from the Oak Ridge Reservation (USDOE)

Oak Ridge, Anderson County, Tennessee

EPA FACILITY ID: TN1890090003

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Prepared by:
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Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and cleanup of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. The public health assessment program allows the scientists flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations—the structure may vary from site to site. Whatever the form of the public health assessment, the process is not considered complete until the public health issues at the site are addressed.

Exposure

As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects

If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances than adults. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high-risk groups within the community (such as the elderly, chronically ill, and people engaging in high-risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic, and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When it touches on cases in which this is so, this report suggests what further public health actions are needed.

Conclusions

This report presents conclusions about the public health threat, if any, posed by a site. Any health threats that have been determined for high-risk groups (such as children, the elderly, chronically ill people, and people engaging in high-risk practices) are summarized in the Conclusions section of the report. Ways to stop or reduce exposure are recommended in the Public Health Action Plan section.

ATSDR is primarily an advisory agency, so its reports usually identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Community

ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments

If, after reading this report, you have questions or comments, we encourage you to send them to us. Letters should be addressed as follows:

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Table of Contents

List of Appendices

List of Tables

List of Figures

Acronyms

ALARA	as low as reasonably achievable
ALI	annual limits on intake
ALS	amyotrophic lateral sclerosis
AOEC	Association of Occupational and Environmental Clinics
ATSDR	Agency for Toxic Substances and Disease Registry
Bq	becquerel
BSCP	Background Soil Characterization Project
CDC	Centers for Disease Control and Prevention
Ce 144	cerium 144
CED	committed effective dose
CEDR	Comprehensive Epidemiologic Data Resource
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFRF	consolidated fuel recycling facility
Ci	curie
cm	centimeter
Co 60	cobalt 60
COC	contaminant of concern
COPD	chronic obstructive pulmonary disease
CRM	Clinch River mile
Cs 137	cesium 137
D&D	decontaminating and decommissioning
DCF	dose conversion factor
DDREF	dose and dose rate effectiveness factor
DOE	U.S. Department of Energy
EDE	effective dose equivalent
EE/CA	Engineering Evaluation/Cost Analysis
EEVOC	East End Volatile Organic Compound (plume)
EFPC	East Fork Poplar Creek
EMEG	Environmental media Evaluation Guides
EPA	U.S. Environmental Protection Agency
ERAMS	Environmental Radiation Ambient Monitoring System
ETTP	East Tennessee Technology Park
FACA	Federal Advisory Committee Act
FAMU	Florida Agriculture and Mechanical University
FDA	Food and Drug Administration
FFA	Federal Facility Agreement
FFAB	Federal Facilities Assessment Branch
GAAT	gunite and associated tanks
GAO	General Accounting Office
Gy	gray
H3	tritium
HF	hydrofracture facility
HFIR	high flux isotope reactor
Hg	mercury

Acronyms (continued)

HRE	homogeneous reactor experiment
HRSA	Health Resources Services Administration
IAG	interagency agreement
ICRP	International Commission on Radiological Protection
IHP	intermediate holding pond
IROD	Interim Record of Decision
I 131	iodine 131
ISV	in situ vitrification
IWMF	interim waste management facility
JEM	Johnson-Ettinger Model
LEFPC	Lower East Fork Poplar Creek
LET	Linear Energy Transfer
LLLW	liquid low-level waste
LNT	linear no-threshold
LTHA	lifetime health advisory
LWBR	Lower Watts Bar Reservoir
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MEPAS	Multimedia Environmental Pollutant Assessment System
MeV	million electron volts
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mGy	milligray
mrem	millirem
µCi/mL	microcuries per milliliter
µg/L	micrograms per liter
µR/hr	microroentgen per hour
MRL	minimal risk level
MS	multiple sclerosis
MSRE	molten salt reactor experiment
mSv	millisievert
MVST	Melton Valley storage tanks
mya	million years ago
Nb 95	niobium 95
NCEH	National Center for Environmental Health
NCRP	National Council on Radiation Protection and Measurements
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHF	new hydrofracture facility
NIOSH	National Institute for Occupational Safety and Health
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
OHF	Old Hydrofracture Facility
OREIS	Oak Ridge Environmental Information System

Acronyms (continued)

ORGDP	Oak Ridge Gaseous Diffusion Plant
ORHASP	Oak Ridge Health Agreement Steering Panel
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ORRHES	Oak Ridge Reservation Health Effects Subcommittee
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
P&A	plugging and abandonment
PAG	FDA protective action guide
PCB	polychlorinated biphenyl
pCi	picocurie
pCi/L	picocurie per liter
PCM	Poplar Creek mile
PDF	portable document format
PHAP	Public Health Action Plan
PHAWG	Public Health Assessment Work Group
ppb	parts per billion
ppm	parts per million
PWSB	process waste sludge basin
PWTP	Process Waste Treatment Plant
rad	radiation absorbed dose
RAR	Remedial Action Report
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RER	remediation effectiveness report
RfC	reference concentration
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
RMEG	Reference Dose Media Evaluation Guides
ROD	Record of Decision
Ru 106	ruthenium 106
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
SNF	spent nuclear fuel
SRS	sediment retention structure
Sr 90	strontium 90
Sv	sievert
SWSA	solid waste storage area
TDEC	Tennessee Department of Environment and Conservation
TDOH	Tennessee Department of Health
TRM	Tennessee River Mile
TRU	transuranic waste
TSCA	Toxic Substances Control Act
TSF	tower shielding facility
TVA	Tennessee Valley Authority

Acronyms (continued)

TWRA	Tennessee Wildlife Resources Agency
U 233	uranium 233
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound
WAC	waste acceptance criteria
WAG	waste area grouping
WBRIWG	Watts Bar Reservoir Interagency Work Group
WIPP	waste isolation pilot plant
WOC	White Oak Creek
WOCE	White Oak Creek Embayment
W_R	radiation weighting factor
W_T	tissue weighting factor
Zr 95	zirconium 95

I. Summary

In 1942, the federal government established the Oak Ridge Reservation (ORR) in Anderson and Roane Counties in Tennessee as part of the Manhattan Project to research, develop, and produce special radioactive materials for nuclear weapons. Four facilities were built at that time. The Y-12 Complex, the K-25 site, and the S-50 site were created to enrich uranium. The X-10 site was created to demonstrate processes for producing and separating plutonium. Since the end of World War II, the role of the ORR (Y-12 Complex, K-25 site, and X-10 site) broadened widely to include a variety of nuclear research and production projects vital to national security.

In 1989, the ORR was added to the U.S. Environmental Protection Agency's (EPA's) National Priorities List (NPL) because, over the years, the ORR operations have generated a variety of radioactive and nonradioactive wastes that a portion of which remain in old waste sites and some pollutants have been released into the environment. The U.S. Department of Energy (DOE) is conducting clean up activities at the ORR under a Federal Facility Agreement (FFA) with EPA and the Tennessee Department of Environment and Conservation (TDEC). These agencies are working together to investigate and take remedial action on hazardous waste from past and present activities at the site.

ATSDR is the principal federal public health agency charged with evaluating human health effects of exposure to hazardous substances in the environment. Prior to this public health assessment, ATSDR addressed current public health issues related to off-site areas, including the East Fork Poplar Creek area and the Watts Bar Reservoir area.

I.A. Scope of this Public Health Assessment

This public health assessment is focused solely on evaluating the potential off-site exposures to contaminated groundwater emanating from ORR. Exposures to groundwater within the ORR boundaries are not considered in this document. Likewise, exposures to contaminated surface water will not be evaluated in this document – even though this contamination may be a result of discharge from contaminated groundwater. Exposure to contamination in surface water and other media is addressed in other ATSDR public health assessments including: Current & Future Chemical Exposure Evaluation (1990-2003), White Oak Creek Radionuclide Releases, and Y-12 Mercury Releases PHA's.

The overall goal of this PHA is to determine the potential public health hazard posed by historical releases of contaminants to groundwater. It will accomplish this goal by evaluating all currently available groundwater monitoring data as well as demographic and current and historical land and groundwater use information. This information will be used to determine whether members of the community are being exposed to contaminated groundwater emanating from ORR. Another goal of this PHA is to fully address specific community concerns solicited by ATSDR as part of the public health assessment process about site-related public health issues relating to exposure to off-site groundwater.

I.B. ATSDR's Evaluation of Exposure to Contaminated Off-Site Groundwater

Based on available data, off-site contamination has only occurred in monitoring wells and seeps/springs in Union Valley, and residential wells have been unaffected by contamination resulting from ORR activities. Since nearly all groundwater beneath the ORR ends up as surface water before leaving the site, community exposure to contamination via off-site groundwater is unlikely.

The east end volatile organic compound (EEVOC) groundwater contaminant plume, extending east-northeast from the Y-12 Complex, is the only confirmed off-site contaminant plume migrating across the ORR boundary. This carbon-tetrachloride dominated plume is actually several contaminant plumes that have commingled and have migrated east-northeast off-site into Union Valley. Institutional controls are set forth in the Interim Record of Decision for Union Valley (Jacobs EM Team, 1997), in which, DOE requires license agreements with property owners whereby DOE will notify them of the potential of contamination and requiring property owners to inform DOE 90 days prior to any changes in groundwater use. It also requires appropriate verification by DOE of compliance with the agreements and notification of state and local agencies. While this selected action does not provide for reduction in toxicity, mobility or volume of contaminants of concern, ATSDR scientists conclude that it is protective of public health to the extent that it limits or prevents community exposure to contaminated groundwater in Union Valley.

ATSDR scientists have concluded that there is no exposure to contaminated groundwater emanating from ORR. Therefore, the groundwater does not pose a public health hazard. Sufficient evidence exists that no human exposures to off-site contaminated groundwater have occurred, no exposures are currently occurring, and exposures are not likely to occur in the future (ATSDR 2005). ATSDR also examined the possibility of vapor intrusion of VOCs into an office building which partially overlies the EEVOC plume. Conservative modeling results estimate indoor vapor concentrations several orders of magnitude below Occupational Safety and Health Administration and National Institutes for Occupational Safety and Health guidelines. ATSDR scientists have concluded that exposure via vapor intrusion does not represent a health threat.

II. Background

II.A. Site Description

In 1942, during World War II, the U.S. government developed the Oak Ridge Reservation (ORR) under the Manhattan Project initiative to produce and study nuclear material needed to make nuclear weapons (ChemRisk 1993b). The ORR is located in eastern Tennessee, in the city of Oak Ridge, approximately 15 miles west of Knoxville; it is situated in both Roane and Anderson Counties. The southern and western borders of the ORR are formed by the Clinch River, and most of the reservation lies within the Oak Ridge city limits. The ORR plants are isolated from the city's populated areas. Figure 1 shows the location of the ORR.

When the federal government acquired the ORR in 1942, the reservation consisted of 58,575 acres (91.5 square miles). Since that time, the federal government has transferred 24,340 (38.0

square miles) of the original 58,575 acres to other parties (e.g., City of Oak Ridge, Tennessee Valley Authority [TVA]); the U.S. Department of Energy (DOE) continues to control the remaining 34,235 acres (53.5 square miles) (Jacobs Engineering Group Inc. 1996; ORNL 2002).

Under the Manhattan Project, the government constructed four facilities at the ORR. The X-10 site (formerly known as the Clinton Laboratories and is now part of what is referred to as the Oak Ridge National Laboratory [ORNL]) was built to produce and separate plutonium. The K-25 site (formerly known as the Oak Ridge Gaseous Diffusion Plant [ORGDP] and now referred to as the East Tennessee Technology Park [ETTP]), the Y-12 plant (now known as the Y-12 National Security Complex), and the former S-50 site (now part of the ETTP) were developed to enrich or process uranium (ChemRisk 1993b; Jacobs Engineering Group Inc. 1996; TDEC 2002; TDOH 2000).

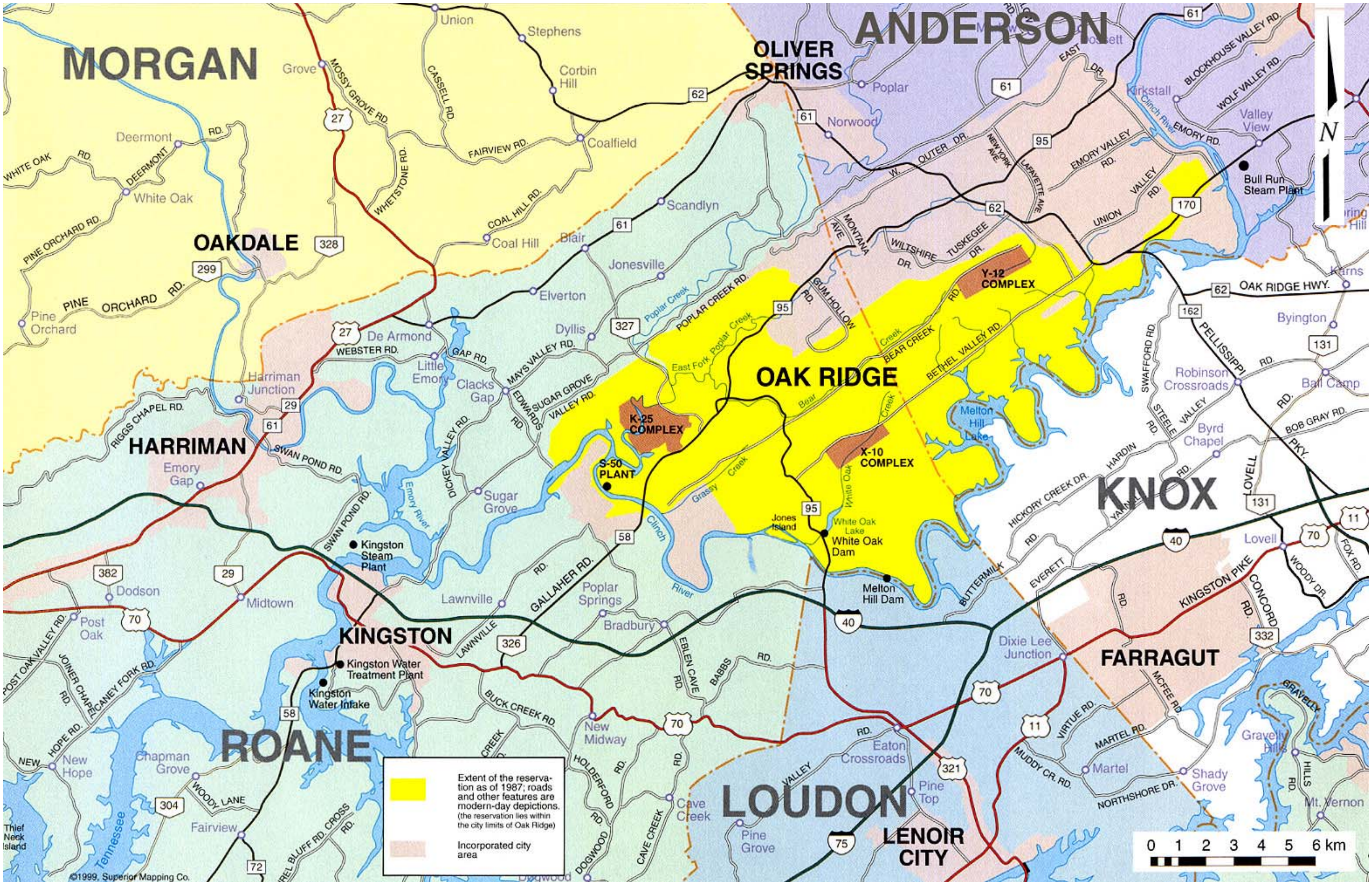

Figure 1: Location of the Oak Ridge Reservation

II.B. Site Geology/Hydrogeology

ORR is located in the East Tennessee Valley, which is part of the Valley and Ridge Province of the Appalachian Mountains. The East Tennessee Valley is bound to the west by the Cumberland Mountains of the Appalachian Plateau Province and to the east by the Smokey Mountains of the Blue Ridge Province. The defining characteristics of the Valley and Ridge Province are the southwest trending series of ridges and valleys caused by crustal folding and faulting due to compressive tectonic forces as well as the differential weathering of the various formations underlying the area.

The contaminated areas on the ORR were separated into large tracts of land that are typically associated with the major hydrologic watersheds (EUWG 1998). These watersheds are:

1. East Tennessee Technology Park (ETTP) Watershed
2. Bethel Valley Watershed
3. Melton Valley Watershed
4. Bear Creek Valley Watershed
5. Upper East Fork Poplar Creek (UEFPC) Watershed

For the purposes of this health assessment, the ETTP Watershed will be discussed independently, but the Bethel Valley and Melton Valley Watersheds will be discussed together, as will the Bear Creek Valley and UEFPC Watersheds. These groupings were made based on the similar hydrogeology of watersheds as well as the similarity of the nature of ORR operations in each watershed.

The vast majority of information available concerning the geology and hydrogeology of the site indicates that groundwater occurs as shallow flow with short flow paths to surface water (ORNL 1982, MMES 1986, USGS 1986b, USGS 1988, USGS 1989, USDOE 2004, SAIC 2004). The fractures and solution cavities, which are common in this karst region, occur in shallow (0-100 ft. deep) bedrock and significantly decrease at depth (>100 ft. deep). In the aquitard formations (see Table B-1) as much as 95% of all groundwater occurs in the shallow zone and discharges into local streams and eventually into the Clinch River. In the aquifer formations, the Knox Aquifer being the most important, solution conduits can make flow paths much deeper and longer along strike; however, there is no evidence of deep regional flow off of the ORR or between basins (USDOE 2004). Please refer to Appendix B for a discussion of ORR geology and general groundwater flow principles relative to the area.

It is important to note that conclusions reached in this Public Health Assessment are based upon currently available data and are limited by the uncertainties inherent in both the data and the general nature of karst groundwater systems. Please refer to Appendix B for a discussion of karst systems on and around the ORR and their impact on groundwater flow.

Groundwater beneath the ORR is typically very shallow and approximately 95% ends up as surface water before leaving the site boundary (USDOE 2004).

It is unlikely that contaminated groundwater at the ORR will flow beneath, and continue to flow away from, streams and rivers that surround the site. There is an extensive interconnection between groundwater and surface water and groundwater contamination sources on the ORR are primarily in the shallow subsurface (with the exception of deep-well injection conducted at ORNL, which will be discussed in the Melton Valley Watershed section of this document). Furthermore, core samples have shown that beneath the alluvium at the bottom of the stream beds in this area is a silty-clay horizon that likely impedes downward groundwater movement (USGS 1989). The incised meander (see Appendix A) of the Clinch River in bedrock also represents a major topographic feature that prevents groundwater from passing beneath the river (ORNL 1982). ATSDR scientists conclude that on-site contaminated groundwater does not likely migrate beneath and away from streams and rivers either as slug-flow or in fractures, solution channels, or other conduits in the bedrock.

II.C. Off-Site Groundwater Data

ATSDR scientists queried the Oak Ridge Environmental Information System (OREIS) Database for all groundwater sampling data from residential wells, monitoring wells, and from seeps and springs. The query resulted in over 2150 on-site sampling locations and over 120 off-site sampling locations with hundreds of thousands of data points with dates ranging from the mid 1980's to 2004. The specific sources of data are:

- ORNL Groundwater Monitoring Data (1991-2004)
- ORNL Bethel Valley Watershed RI 1997
- ORNL White Oak Creek Watershed RI 1996
- Y-12 Upper East Fork Poplar Creek RI 1997
- Y-12 Groundwater Protection Program (Ongoing)
- ORR Integrated Water Quality Program 1998
- ORR Water Resources Restoration Program (Ongoing)
- ORR Remediation Effectiveness Reports (2000-2005)
- K-25, K-1070-A Burial Ground – Brashears Creek
- Lower East Fork Poplar Creek Operable Unit
- Atomic City Auto Parts Site Characterization
- TDEC Environmental Monitoring Reports (through 2003)

In 1996, TDEC initiated a residential well sampling program. Seventy-one (71) residential wells were identified for sampling. Most were situated southwest and within 2 miles of ORR boundaries because, based on the hydrology and geomorphology of the area, these were the areas most likely affected by contaminated groundwater from ORR. In conjunction with the residential well sampling program, TDEC conducted a house-to-house survey of homeowners about their concerns with groundwater. The results of this survey revealed that there were no anecdotal problems with groundwater quality. The analytical results of the residential well sampling program indicated that there was no "discernable" impact on residential wells from activities on the ORR (TDEC 2004).

These sampling locations were first separated into on- and off-site locations. Since this health assessment focuses on off-site (outside ORR boundaries) exposure to groundwater contamination, only off-site sampling data were evaluated. Next, the sampling locations were differentiated based whether they came from residential wells, monitoring wells, or from seeps and springs. A further distinction was made based upon proximity of the sampling locations to the main facilities of ORR: near ETTP, near ORNL, or near the Y-12 Complex. Maps are included (Figure 4, Figure 8, and Figure 14) and sampling results will be discussed for each area in the respective sections.

The only data gaps that were identified during the data evaluation process were the relative irregularity of residential well sampling. These wells are not regularly and systematically sampled in the same way that monitoring wells are. In TDEC's 2005 Environmental Monitoring Plan (TDEC 2005), "older" residential wells are typically only sampled when there is a specific request or other justification to do so. In the mid-1990's, when the majority of available data in the OREIS database was collected, TDEC conducted a sweeping residential well sampling as part of their 1996 Residential Well Sampling Program. Newly installed residential wells are included in the current (2005) sampling plan.

It should be noted that TDEC's residential well sampling program was never intended to be a comprehensive characterization of off-site well contamination. So, we include the lack of residential well sampling data as a "data gap" not to criticize the efforts of TDEC but to highlight an area where sufficient data is unavailable.

II.D. East Tennessee Technology Park (ETTP) Watershed

The 1,700-acre K-25 site, which includes the former S-50 plant (37 acres), is now called the East Tennessee Technology Park (ETTP). The K-25 site is close to the ORR's western border (Figure 2); it is situated along Poplar Creek, near the creek's confluence with the Clinch River in Roane County, approximately 10 miles west of downtown Oak Ridge (ChemRisk 1999a; U.S. DOE 1996).

Operational History

In October 1944, the S-50 plant started separating uranium by liquid thermal diffusion; the plant closed in September 1945. The K-25 site was used from 1945 to 1964 to enrich weapons-grade uranium through gaseous diffusion. From 1965 to 1985, the site used uranium hexafluoride in the gaseous diffusion process to manufacture commercial-grade uranium. All gaseous diffusion operations ceased at the site in 1985, and the site was closed in 1987. Since 1996, reindustrialization has been the focus of the K-25 site, which now houses two business centers—the Heritage Center and the Horizon Center. The site also maintains the Toxic Substances and Control Act (TSCA) incinerator; it is the only facility in the country authorized to incinerate wastes with radioactive and hazardous contaminants that contain PCBs.

Geology/Hydrogeology

The ETTP was constructed almost entirely on the limestone bedrock of the Chickamauga Group (see Figure B-1). The Chickamauga Group is between 450 and 600 meters thick in the Oak Ridge area. Although the formation is predominantly limestone in composition, it resists dissolution and large cavities are rare. Consequently, water storage remains near the surface in the unconsolidated zone because of the low hydraulic conductivity of the bedrock. Cracks and fissures do occur in the Chickamauga Group and, therefore, prevent any prediction of groundwater flow direction and rate in the bedrock (MMES 1986, USGS 1986B, USGS 1988, USGS 1989, SAIC 2004). However, since these cracks and fissures decrease with depth, deep groundwater flow is very limited. The Chickamauga Group is considered a flow-limiting aquitard (ORNL 1982, MMES 1985, USGS 1997). The lithology of the Rome Formation, which underlies the southeastern portion of the ETTP, consists of shales and siltstones which have typically low hydraulic conductivities; however, due to the complex fractures and fissures in this formation, it is also nearly impossible to accurately predict a flow path for groundwater in this formation (Figure 3).

Because the local water table occurs just below the surface in the unconsolidated zone, groundwater flow is generally consistent with the surface topography. However, the rate and direction of groundwater flow in the ORR vary, and are often affected by fluctuations in precipitation as well as flood control operations both up and down stream. Groundwater recharge comes from diffuse rainwater infiltration through the permeable, well-drained silty soils typical of the area. However, during high precipitation events, the clay content in the soil can prevent rapid infiltration and may result in significant surface run-off. Groundwater discharge occurs through evapotranspiration during the spring and summer months, but is predominantly discharged into surface water via seeps and springs. Most groundwater at ORR ultimately ends up in the Clinch River serving as base flow for small streams and tributaries, including Mitchell Branch and Poplar Creek near the ETTP area (MMES 1985, SAIC 2004).

Contamination at ETTP

The primary contaminants in sediments at ETTP are inorganic elements, radionuclides, and polychlorinated biphenyls (PCBs). In soils, the contaminants of concern include inorganic elements, radionuclides, semi-volatile organic compounds (SVOCs), polyaromatic hydrocarbons (PAHs), and VOCs. However, the primary contaminants of concern in groundwater at ETTP are VOCs. Dye tracing has been used to identify exit points for groundwater discharge to surface waters around the ETTP. Monitoring wells have been installed at each of these exit points to evaluate contaminant concentrations in these areas and to monitor the migration of known contaminant plumes. As of FY 2003 sampling, volatile organic compound (VOC) concentrations have shown a general decreasing trend at exit point monitoring wells. Results from monitoring of the bedrock well (BRW-083) and the unconsolidated zone well (UNW-107) near the confluence of Mitchell Branch and Poplar Creek, have shown no detectable levels of VOCs (Figure 2). These wells are considered a significant exit point for several commingling groundwater plumes emanating from the eastern portions of ETTP, including the K-1070-C/D burial grounds and the K-1401 area.

Testing at exit point monitoring wells BRW-035 and BRW-068, between the K-901 holding pond and the Clinch River, have occasionally shown low concentrations of TCE and 1,2-DCE, chloroform, gross alpha and gross beta activity; all below the respective MCLs. VOC contaminated groundwater does, however, discharge to surface water from several seeps and springs north of the K-901 holding pond including Spring 21-002.

Another significant contaminant source area for the ETTP is the K-27 building. VOC concentrations in the groundwater in this area range from 20 μg/L (UNW-096) to 130 μg/L (UNW-038). Both of these unconsolidated zone monitoring wells are southwest of K-27 along Poplar Creek. Monitoring wells (BRW-016) north of K-27 along Poplar Creek typically reveal TCE degradation products such as *cis*-1,2-DCE and vinyl chloride. FY 2003 sampling from BRW-016 revealed vinyl chloride concentrations slightly above the MCL of 2 μg/L.

As is the case north of K-27, the distal portions of the commingled VOC plumes near the Mitchell Branch are largely composed of TCE degradation products *cis*-1,2-DCE and vinyl chloride. In both cases, this can indicate that the source of contamination is significantly upgradient or the source of contamination has been eliminated. It could also be a result of increased biodegradation in those particular areas. Based on monitoring data from FY 2003 collected from known and suspected exit point locations, contaminant (largely VOC) concentrations have either remained constant or have decreased from previous years. These steady or decreasing groundwater concentrations have also resulted in decreased impact on ETTP perimeter surface waters. VOC concentrations from the Mitchell Brach weir (K-1700 – see Figure 3 inset) have decreased from 1997-98 (SAIC 2004).

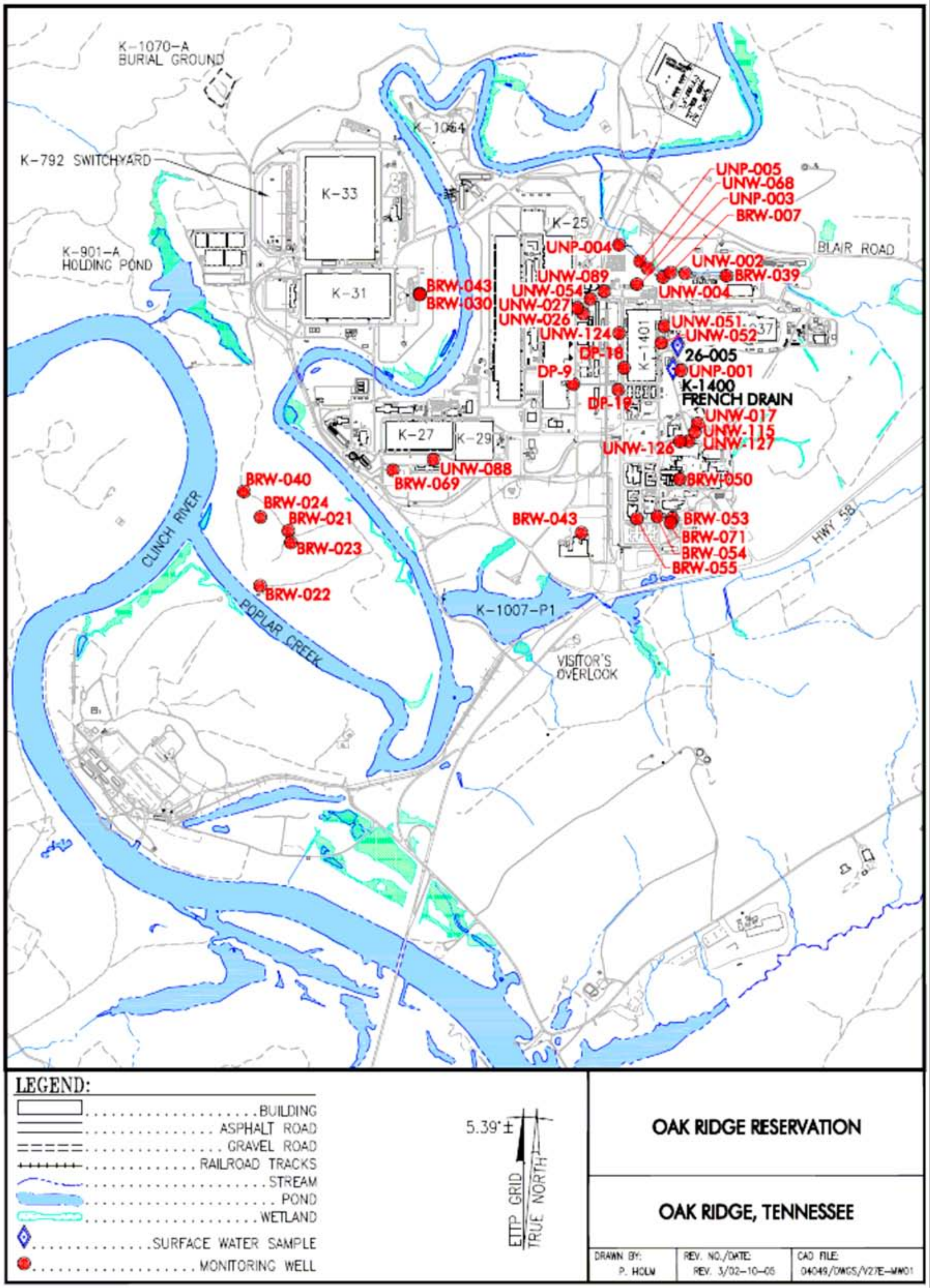

Figure 2: On-Site Groundwater Monitoring Locations at ETTP

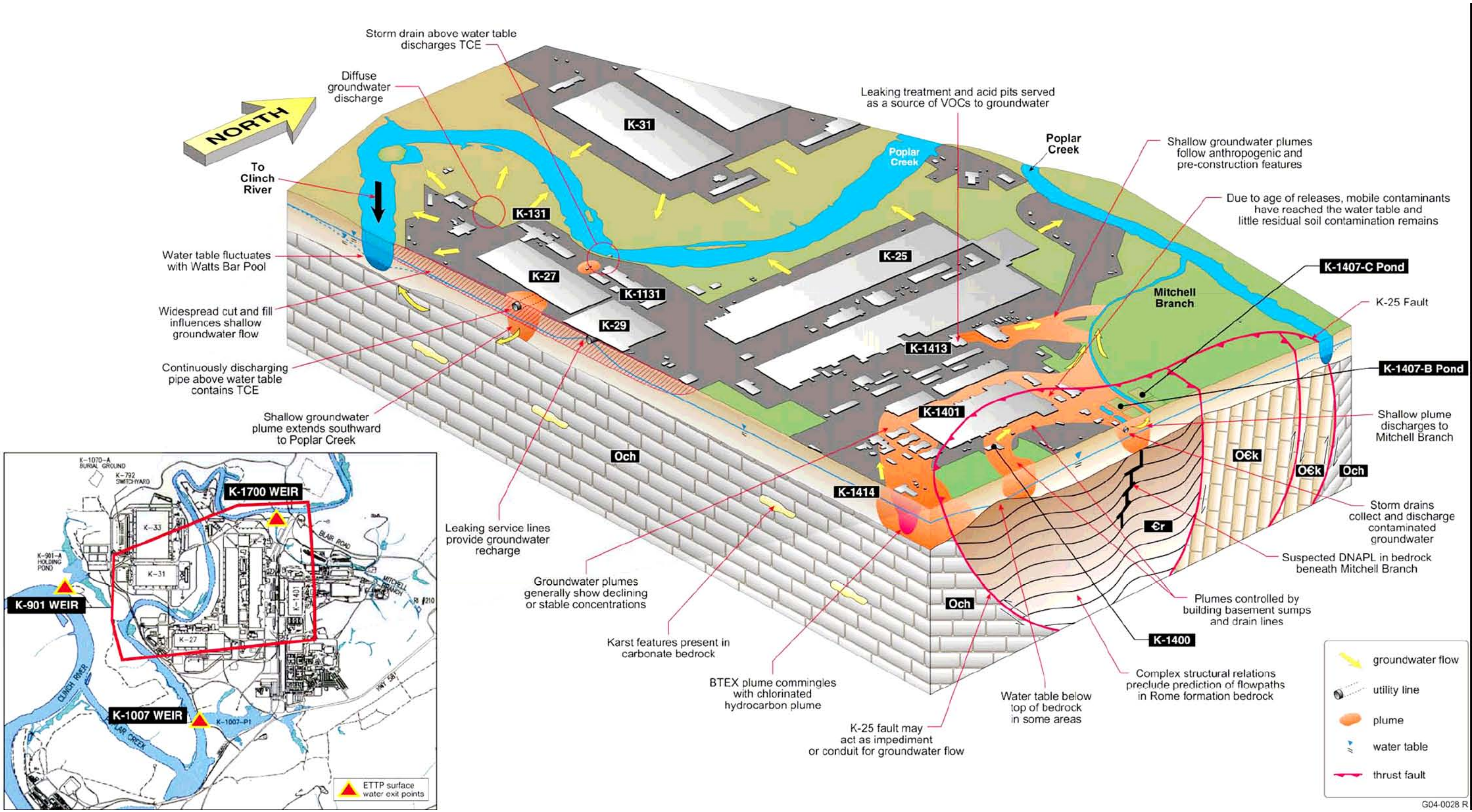

Figure 3: Conceptual Model of Groundwater Flow and Contaminant Transport at ETTP

Off-Site Groundwater Monitoring Data

Seeps and Springs

Comparison values are doses or substance concentrations set well below levels that are known or anticipated to result in adverse heath effects (ATSDR 2005) — see Appendix A.

Lead and manganese were the only substances detected above comparison values (CVs) in seeps and springs near ETTP. Lead was only detected in five samples out of 28. Three out of those were above the 15 ppb MCL for lead. Of the 12 detected samples of manganese, only one sample was above the 500 ppb CV for manganese. For both substances, all samples that were detected above the respective CVs were taken from the CCC Well #2 (See Figure 4). Samples taken from an adjacent location (CCC Well #1) on the same day(s) were below detection limits for both substances.

Table 1: Contaminants Detected Above Comparison Values in Seeps or Springs Near ETTP

Substance	*Detects / Samples*	*Samples Detected Above CVs*	*CV (ppb)*	*Max Conc. (ppb)*	*Max Location*	*Max Conc. Date*
Lead	5 / 28	3	15	95.4	CCC Well #2	3/5/1996
Manganese	12 / 15	1	500	995	CCC Well #2	9/8/1995

Monitoring Wells

There were no contaminants detected above CVs in monitoring wells outside of the ORR boundaries near the ETTP.

Residential Wells

The only contaminant detected above CV in residential wells near ETTP is boron. Boron has been detected in four samples from four different wells collected on September 22, 1998. Only one of these samples was detected above the 100 ppb CV. This sample was taken from RW-A-15 and yielded a boron concentration of 154 ppb. No subsequent sampling has been conducted at these wells.

ATSDR Conclusion for the ETTP Watershed

Lead, manganese and boron are naturally occurring elements. Lead and manganese were both detected above CVs in seeps outside the ORR. Because neither lead nor manganese could be detected in samples collected concurrently at adjacent sampling locations, it is unlikely that these substances are associated with groundwater contamination. Likewise, boron was only detected above it’s CV in one sample. Concurrent sampling at adjacent wells revealed concentrations well below the CV. Exit pathway monitoring wells are being continually monitored as part of the Water Resources Restoration Program for ETTP. Groundwater contamination at ETTP does not migrate off-site; rather, it is discharged into surface water. The ETTP Environmental Monitoring Plan includes surface water surveillance (ORNL 2004). ATSDR scientists conclude that the public (community) is not being exposed to groundwater contamination from ETTP.

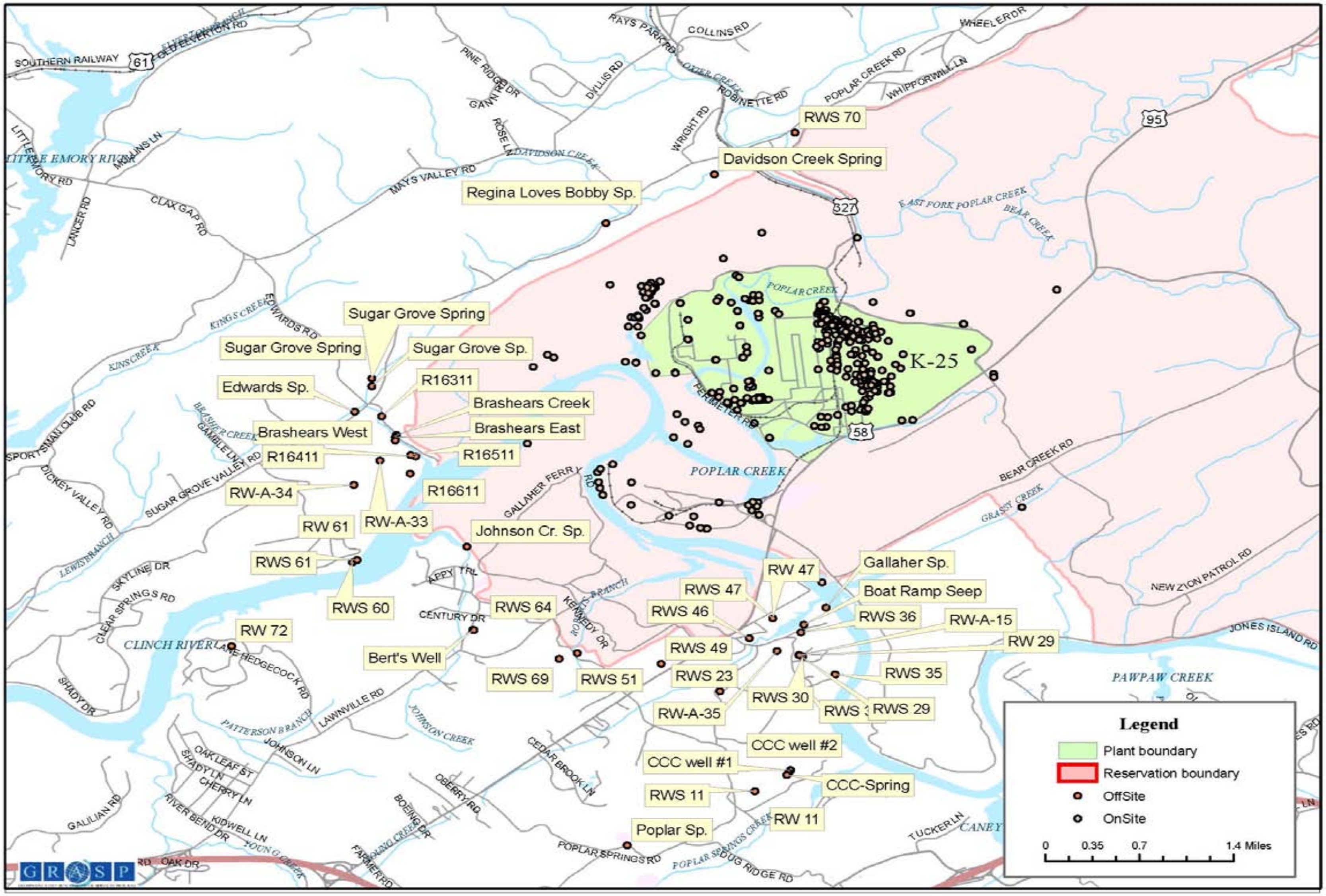

Figure 4: Off-Site Groundwater Sampling Locations Near ETTP